

WHAT IS CLAIMED IS:

1 1. A system for operating a power amplifier in a mobile handset, comprising:
2 a carrier amplifier having a carrier input terminal and a carrier output terminal;
3 a peak amplifier having a peak input terminal, a peak output terminal and a control
4 terminal for receiving a voltage control signal, the peak amplifier configured
5 to vary at least one characteristic of the power amplifier based upon the
6 voltage control signal;
7 an active phase shifter, coupled to the carrier input terminal and the peak input
8 terminal, for generating a peak amplifier input signal delayed in phase from a
9 carrier amplifier input signal; and
10 an output matching unit, coupled to the carrier output terminal and the peak output
11 terminal, for transmitting a carrier output power signal and a peak output
12 power signal and forming a power amplifier output power signal at a power
13 amplifier output stage.

1 2. The system of claim 1, wherein the active phase shifter further comprises:
2 a lower differential unit, coupled to an input stage and the peak input terminal, for
3 generating the peak amplifier input signal;
4 an upper differential unit, coupled to the input stage and the carrier input terminal, for
5 generating the carrier amplifier input signal; and
6 a phase control unit, coupled to the input stage and the upper differential unit, for tuning
7 a phase difference between the peak amplifier input signal and the carrier
8 amplifier input signal within a phase tolerance.

1 3. The system of claim 2, wherein the lower differential unit comprises a first active
2 component.

1 4. The system of claim 3, wherein the first active component is a common-emitter bipolar
2 transistor.

1 5. The system of claim 3, wherein the first active component is a common-source field
2 effect transistor.

1 6. The system of claim 2, wherein the upper differential unit comprises a second active
2 component.

1 7. The system of claim 6, wherein the second active component is a common-base bipolar
2 transistor.

1 8. The system of claim 6, wherein the second active component is a common-gate field
2 effect transistor.

1 9. The system of claim 2, wherein the phase control unit is an Inductor-Capacitor (LC)
2 circuit.

1 10. The system of claim 1, wherein the active phase shifter, the carrier amplifier, the peak
2 amplifier, and the output matching unit are integrated on a semiconductor die.

1 11. The system of claim 1, wherein the active phase shifter is realized on a first
2 semiconductor die, and the carrier amplifier, the peak amplifier, and the output matching unit
3 are integrated on a second semiconductor die.

1 12. The system of claim 2, wherein the phase control unit is realized on a first
2 semiconductor die, and the upper differential unit, the lower differential unit, the peak
3 amplifier, the carrier amplifier, and the output matching unit are integrated on a second
4 semiconductor die.

1 13. The system of claim 1, wherein the output matching unit further comprises:
2 a first transformer having a first input coupled to the carrier output terminal and a first
3 output coupled to the peak output terminal; and
4 a second transformer having a second input coupled to the output of the first transformer
5 and a second output coupled to the power amplifier output stage.

1 14. The system of claim 1, wherein the output matching unit is implemented with lumped
2 elements.

1 15. The system of claim 1, wherein the at least one characteristic of the power amplifier is
2 linearity.

1 16. The system of claim 1, further comprising a baseband modem chipset for receiving
2 signals transmitted by a remote base station and generating the voltage control signal in a first
3 voltage state if power levels of the received signals indicate that the power amplifier operates
4 within a low power range and generating the voltage control signal in a second voltage state if
5 the power levels of the received signals indicate that the power amplifier operates within a high
6 power range.

1 17. The system of claim 16, wherein the low power range and the high power range are
2 separated by an output power threshold of 10-19 dBm.

1 18. The system of claim 16, wherein the peak amplifier further comprises a voltage control
2 unit configured to receive the voltage control signal and control a bias current of the peak
3 amplifier such that the power amplifier is operated as a Doherty-type amplifier when the
4 voltage control signal is in the first voltage state and the peak amplifier is operated as a class
5 AB amplifier when the voltage control signal is in the second voltage state.

1 19. The system of claim 1, wherein the peak amplifier input signal is shifted in phase from
2 the carrier amplifier input signal by approximately 90 degrees.

1 20. The system of claim 2, wherein the phase tolerance is 5%.

1 21. A method for providing phase control in a Doherty communication amplifier, the
2 Doherty communication amplifier including a carrier amplifier and a peak amplifier,
3 comprising:
4 processing an input signal via an active phase shifter to generate a differential output,
5 the differential output further comprising a first differential output signal and a
6 second differential output signal, the first differential output signal and the second
7 differential output signal having a phase difference; and
8 tuning the phase difference to within a phase tolerance based upon input signal
9 characteristics.

1 22. The method of claim 21, wherein the phase difference is approximately 90 degrees.

1 23. The method of claim 21, wherein the phase tolerance is 5%.

1 24. The method of claim 21, wherein the input signal characteristics include input signal
2 frequency and input signal power.

1 25. The method of claim 21, wherein tuning further comprises tuning the phase difference
2 by electrically coupling circuit elements to the Doherty communication amplifier.

1 26. The method of claim 21, wherein tuning further comprises tuning the phase difference
2 by varying a capacitive value of a phase control unit capacitor via laser trimming of the phase
3 control unit capacitor.

1 27. The method of claim 21, wherein tuning further comprises tuning the phase difference
2 by varying a capacitive value of a phase control unit varactor.

1 28. The method of claim 21, further comprising:
2 receiving signals transmitted by a remote base station;
3 generating a voltage control signal based upon power levels of the signals transmitted by
4 the remote base station; and
5 biasing the peak amplifier via the voltage control signal.

1 29. The method of claim 28, wherein the generating further comprises generating the
2 voltage control signal in a first state if the power levels of the signals transmitted by the remote
3 base station indicate that the Doherty communication amplifier operates in a low output power
4 range.

1 30. The method of claim 29, wherein the voltage control signal in the first state biases the
2 peak amplifier as a class B or a class C amplifier.

1 31. The method of claim 28, wherein the generating further comprises generating the
2 voltage control signal in a second state if the power levels of the signals transmitted by the
3 remote base station indicate that the Doherty communication amplifier operates in a high
4 output power range.

1 32. The method of claim 31, wherein the voltage control signal in the second state biases the
2 peak amplifier as a class AB amplifier.

1 33. A system for providing phase control in a Doherty communication amplifier, the
2 Doherty communication amplifier including a carrier amplifier and a peak amplifier,
3 comprising:
4 means for processing an input signal via an active phase shifter to generate a differential
5 output, the differential output further comprising a first differential output signal
6 and a second differential output signal, the first differential output signal and the
7 second differential output signal having a phase difference; and
8 means for tuning the phase difference to within a phase tolerance based upon input
9 signal characteristics.

1 34. The system of claim 33, wherein means for tuning further comprises means for
2 electrically coupling circuit elements to the Doherty communication amplifier.

1 35. The system of claim 33, further comprising
2 means for receiving signals transmitted by a remote base station;
3 means for generating a voltage control signal based upon power levels of the signals
4 transmitted by the remote base station; and
5 means for biasing the peak amplifier via the voltage control signal.

1 36. The system of claim 35, wherein means for biasing further comprises means for biasing
2 the peak amplifier as a class B or a class C amplifier.

1 37. The system of claim 35, wherein means for biasing further comprises means for biasing
2 the peak amplifier as a class AB amplifier.